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# *Surveying and Mapping Division*

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*PROCEEDINGS OF THE*


AMERICAN SOCIETY
OF CIVIL ENGINEERS

## BASIC REQUIREMENTS FOR MANUSCRIPTS

This Journal represents an effort by the Society to deliver information to the reader with the greatest possible speed. To this end the material herein has none of the usual editing required in more formal publications.

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Journal of the

SURVEYING AND MAPPING DIVISION

Proceedings of the American Society of Civil Engineers



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Papers

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# THE SETUP ERROR IN HORIZONTAL ANGLES

Sumner B. Irish,[1] M. ASCE

## SUMMARY

The effect of the setup error on the accuracy of a horizontal angle is determined. Angular errors seem to be due to the size of the setup error, the length of the lines of sight, and the size of the angle measured. Graphs are presented to facilitate the evaluation of the developed expression.

## INTRODUCTION

The surveyor has long recognized the inherent error in an angle due to the practical difficulties encountered in setting-up a transit directly over the vertex of an angle. Various methods have been developed to facilitate the transit setup; such as, extraordinarily heavy plumb bobs, optical plummets, optical plumb bobs, and the like. However, little is now known as to the magnitude and the effect of this error. An attempt is here made to evaluate this error in horizontal angle measurements.

The transit setup error becomes greater in magnitude as the sides become shorter. This fact, or rather the opposite of it, is recognized in high-order triangulation work in which lengths of sides are often many miles long. Setup error is of little or no significance in this type of surveying. Also, the wind, as it blows the plumb bob about and makes the accurate location of the instrument center difficult, is recognized as a considerable source of error. Excessive wind renders accurate surveying absolutely impossible.

The error in a measured horizontal angle is then seen to be due to, first, the lengths of the lines-of-sight of the angle, and secondly, the error in setting-up the transit over the station. A third factor in the accuracy of a horizontal angle in this type of analysis is the size of the angle. The importance of these three factors will be shown by the proof which follows.

Note: Discussion open until February 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2165 is part of the copyrighted Journal of the Surveying and Mapping Division, Proceedings of the American Society of Civil Engineers, Vol. 85, No. SU 1, September, 1959.

1. Associate Prof. of Civ. Eng., Princeton Univ., Princeton, N. J.

## Derivation

With reference to Fig. 1, the following definitions will be used:

| | |
|---|---|
| O | = true vertex 4 B O A |
| P | = actual instrument center |
| $L_{1,2,3}$ | = theoretical lengths of sides 1, 2, and 3 of $\Delta$B O A |
| $L'_{1,2}$ | = actual lengths of the lines-of-sight 1 and 2 |
| $\theta$ | = true horizontal angle |
| $\theta_1$ | = measured horizontal angle |
| $\epsilon$ | = error in setting-up the transit over 0 |

The angular error, $\Delta\theta$ in the measured horizontal angle is, by definition

$$\Delta\theta = \theta - \theta_1 \tag{1}$$

From Fig. 1, the angular error can be seen to be

$$\Delta\theta = \alpha_1 + \alpha_2 \tag{2}$$

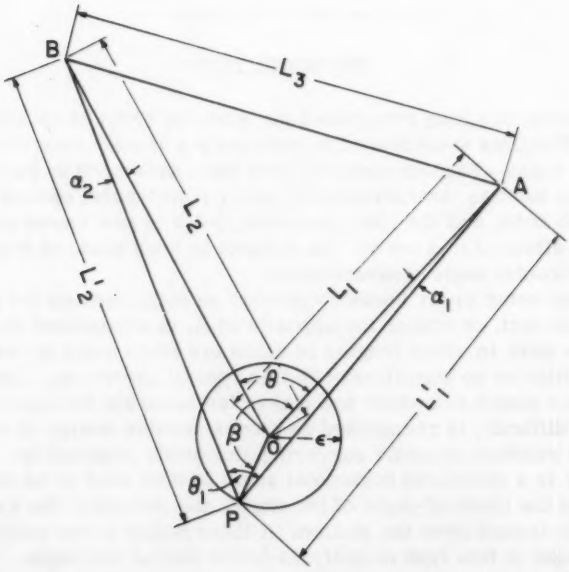


FIGURE 1

STATEMENT OF PROBLEM

but

$$\sin \alpha_1 = \frac{\epsilon \sin(360^\circ - \beta)}{L_1'} \tag{3}$$

$$\sin \alpha_2 = \frac{\epsilon \sin(\beta - \theta)}{L_2'} \tag{4}$$

Since $\alpha_1$ and $\alpha_2$ are small angles, their radian values can be used, and $L_1$ and $L_2$ equal $L_1'$ and $L_2'$ respectively, very nearly, then

$$\alpha_1 = -\frac{\epsilon \sin\beta}{L_1} \tag{5}$$

$$\alpha_2 = \frac{\epsilon(\sin\beta\cos\theta - \cos\beta\sin\theta)}{L_2} \tag{6}$$

and

$$\Delta\theta = -\epsilon\left[\left(\frac{1}{L_1} - \frac{\cos\theta}{L_2}\right)\sin\beta + \left(\frac{\sin\theta}{L_2}\right)\cos\beta\right] \tag{7}$$

Let

$$P = \left(\frac{1}{L_1} - \frac{\cos\theta}{L_2}\right)$$

and

$$Q = \left(\frac{\sin\theta}{L_2}\right)$$

then

$$\Delta\theta = -\epsilon(P\sin\beta + Q\cos\beta) \tag{8}$$

The value of the angular error, $\Delta\theta$, is seen to be dependent on the magnitude of $L_1$, $L_2$, $\theta$, $\epsilon$ and $\beta$. The first four of these terms can be assumed to be known (or approximately so) either from field work (in the case of $L_1$, $L_2$ and $\theta$), or from experience or similar knowledge (in the case of $\epsilon$). $\beta$, on the other hand, is random in nature, and may have any value from $-\pi$ to $+\pi$. It can be assumed, furthermore, that during the course of many setups, this error $\epsilon$ will be uniformly distributed throughout the interval mentioned and will satisfy all the criteria for a normally distributed error.

The standard deviation for $\Delta\theta$ will then, as fundamentally expressed, be

$$\sigma_{\Delta\theta}^2 = \frac{1}{2\pi}\int_{-\pi}^{+\pi} (\Delta\theta)^2 d\beta \tag{9}$$

and

$$\sigma_{\Delta\theta}^2 = \frac{\epsilon^2 (P^2+Q^2)}{2} \tag{10}$$

but

$$P^2+Q^2 = \left(\frac{1}{L_1} - \frac{\cos\theta}{L_2}\right)^2 + \left(\frac{\sin\theta}{L_2}\right)^2$$

$$P^2+Q^2 = \frac{L_3^2}{L_1^2 L_2^2} \tag{11}$$

Then the standard deviation is seen to be

$$\sigma_{\Delta\theta} = \frac{\epsilon L_3}{\sqrt{2} L_1 L_2} \tag{12}$$

## Application

Eq. (12) gives the general expression for the standard deviation of the measured angle, due to the error in setting-up the transit over the vertex of the angle. As can be seen from the expression, the standard deviation is, as might be expected, directly proportional to the error in distance in setting-up over the point, and inversely proportional to the lengths of the two lines of sight. It is also proportional to another term, $L_3$. It is in this term that the size of the angular opening is reflected; the smaller the angular opening, the smaller $L_3$, and consequently the smaller the value of the standard deviation.

In an attempt to arrive at some quantitative figure which might be meaningful, a solution of Eq. (12) will be made, assuming first $L_1 = L_2$ and second $L_1 = 1/4L_2$. For $L_1 = L_2 = L$,

$$L_3 = 2L \sin\frac{\theta}{2} \tag{13}$$

and

$$\sigma_{\Delta\theta} = \frac{\sqrt{2}\epsilon}{L} \sin\frac{\theta}{2} \tag{14}$$

For $L_1 = 1/4L_2$

$$L_3 = L_1 (17 - 8\cos\theta)^{1/2} \tag{15}$$

and

$$\sigma_{\Delta\theta} = \frac{0.5\epsilon (2.125 - \cos\theta)^{1/2}}{L_1} \tag{16}$$

Figs. 2 and 3 give graphical solutions for Eq. (15) and (16) for an $\epsilon = 1/32"$, varying sizes of measured angles and varying lengths of lines of sight.

## CONCLUSIONS

As can be seen from the graphs in Figs. 2 and 3, the angular error introduced by the error in setup can be significant. For an error of 1/32 in. in setup, and lengths of lines of sight of 50 ft. each, the standard deviation in a measured right angle is 10.7", as seen from Fig. 2. For an error of 1/8 in. in setup and lengths of lines of sight of 200' each, the standard deviation in a measured straight angle is 15.2".

Perhaps it would be better to talk in terms of a relationship that is frequently seen and sometimes more readily understood by the surveyor, that

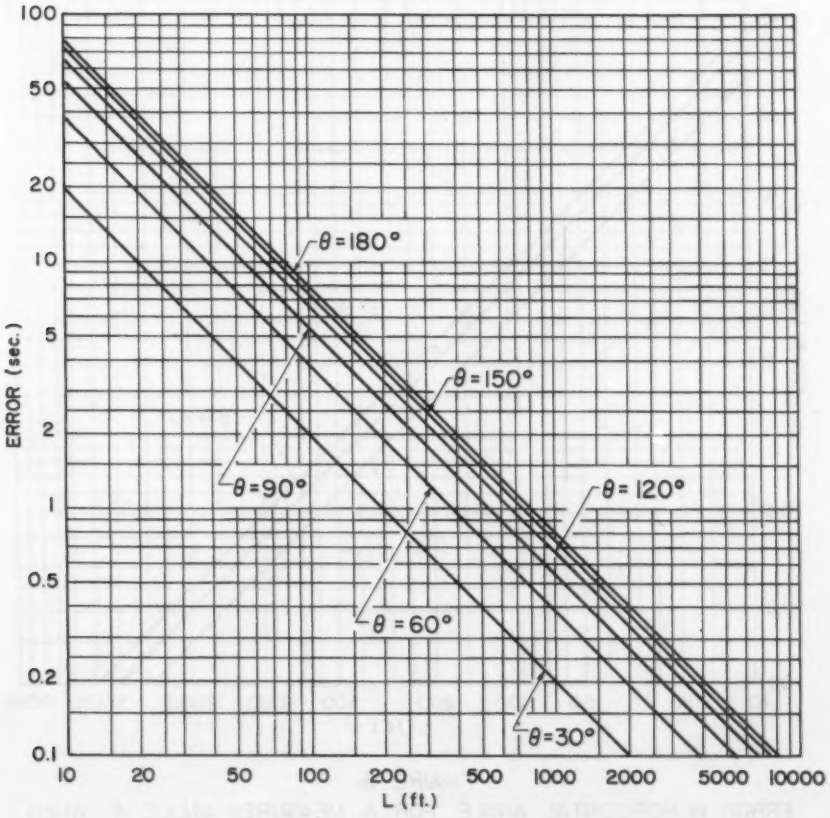


FIGURE 2

ERROR IN HORIZONTAL ANGLE FOR A MEASURED ANGLE $\theta$ WHEN $\epsilon = \frac{1}{32}$ IN, AND $L_1 = L_2$

is, probable error. This is defined as the quantity which, added to and subtracted from the most probable value, fixes the limit within which it is an even chance that the true value of the measured quantity must lie.[2] The probable error is 0.6745 times the standard deviation referred to in the foregoing paragraph. In this connection, it should be pointed out that if the probable error concept is to be used when speaking of the error in the measured angle, the probable error concept must be used in giving the instrument setup error. Similarly, if the standard deviation approach is to be used, the standard deviation in the transit setup must be used in arriving at the standard deviation of the measured angle.

Another aspect of the setup error which should be mentioned is that it is not eliminated by repetition of the angle. This error can be reduced only by

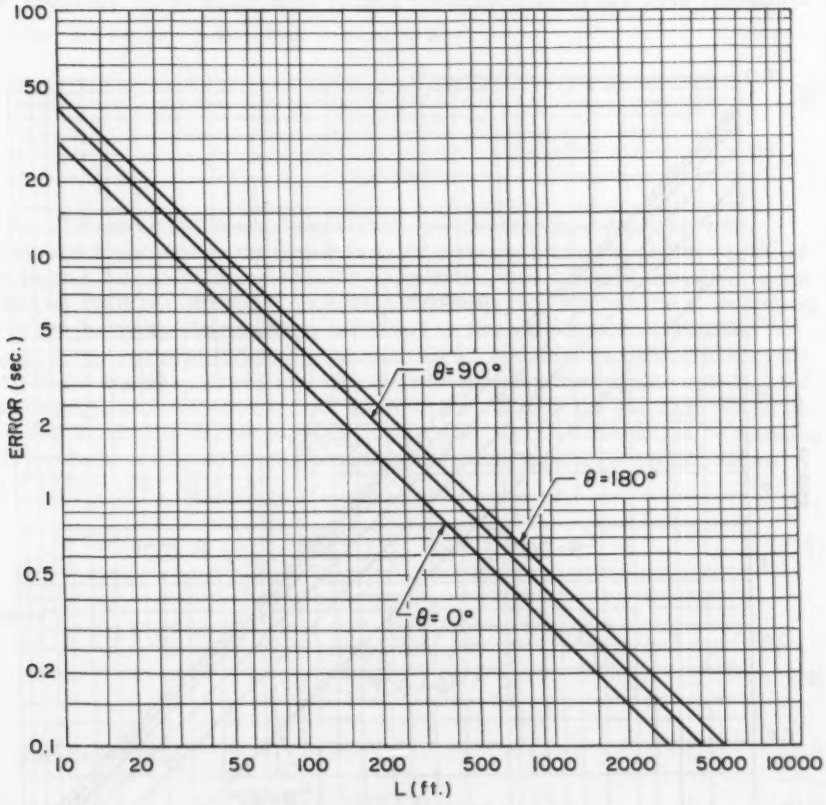


FIGURE 3

ERROR IN HORIZONTAL ANGLE FOR A MEASURED ANGLE $\theta$ WHEN $\epsilon = \frac{1}{32}$ IN, AND $L_1 = \frac{1}{4} L_2$

2. ASCE Manual 34—Definitions of Surveying, Mapping and Related Terms.

1) more care in setting-up the instrument over the point, and 2) additional measurements of the angle by re-setting-up the instrument. The former is to be preferred.

The foregoing analysis represents an attack on one aspect of the angular error problem. Other parts of this problem can be similarly analyzed. Knowledgeable angular measurements can then be made. Until that is done, surveying is largely an art, rather than a science.

Journal of the
SURVEYING AND MAPPING DIVISION
Proceedings of the American Society of Civil Engineers

# STATUS OF SURVEYING AND MAPPING IN THE UNITED STATES[a]

Final Report of the Task Committee on Status of Surveying and Mapping of the Surveying and Mapping Division

## A. General Background of the Problem

In the past decade, certain problems relating to the professional status of its surveying-mapping members prompted the American Society of Civil Engineers in 1954 to inaugurate a study of surveying and mapping activities in the United States. A Task Committee on Status of Surveying and Mapping was appointed to report on two questions:

a. Which parts or activities of surveying and mapping are professional, and which are not?
b. Which parts or activities of surveying and mapping are engineering, and which are not?

These two questions have been under close scrutiny now for nearly four years, and herein are presented the results of various phases of the study.

### Ethical Considerations

The problems that prompted the action mentioned above were typically these:

a. Certain federal surveying-mapping agencies (e.g., Corps of Engineers) and state and municipal bodies were seeking to contract for the hire of surveying personnel on a competitive-price basis, a practice that many ASCE members reported as violating the ASCE code of ethics;
b. Contracts for preparation of topographic maps by use of photogrammetry were frequently awarded to corporations on a competitive-price basis, again suggested as a violation of ethics.

Other problems of a minor nature and similar thereto, not the least being the recurrent question of admitting land (property) surveyors to engineering license or to engineering societies, added weight in favor of the study.

Note: Discussion open until February 1, 1960. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. Paper 2166 is part of the copyrighted Journal of the Surveying and Mapping Division, Proceedings of the American Society of Civil Engineers, Vol. 85, No. SU 1, September, 1959.

a. Endorsed by Executive Committee of Surveying and Mapping Division as Amended: October 15, 1958.

Committee Personnel

The Task Committee is composed of three members: representing federal mapping agencies, Mr. George D. Whitmore, Chief Topographic Engineer of the U. S. Geological Survey, Washington; representing private practice (or industry), Mr. Alfred O. Quinn, Chief Engineer of Aero Service Corporation, Philadelphia; and representing engineering education, Brother B. Austin Barry, Associate Professor of Civil Engineering at Manhattan College, New York, as Chairman.

## B. First Report (1955): What in Surveying is Professional

At the start, it was found necessary to ascertain a good definition of the term professional. In its first report* the Task Committee cited four distinguished authorities and noted that, among other attributes, these are primarily the distinguishing marks of a profession (or of professional work):

a. It is of a high intellectual nature;
b. It must require the exercise of judgment and is not subject to standardization;
c. It must satisfy an important social need;
d. It has a body of advanced knowledge (science) and an art (skill) not commonly possessed by the general public.
e. Its practitioners are usually prepared on the college or university level in a specialized intellectual technique (as well as in general areas of learning);
f. Its members must have a motive of service, assume relations of confidence, and accept individual responsibility;
g. There must be some social recognition and regulation of the profession.

On the basis of these characteristics, all categories of surveying-mapping activity were studied and the individual job classifications were designated as professional-level, technician-level, or preprofessional-level in nature. Definitions were also included for each professional title in the attached classification chart (Appendix D). In each case, the professional person is distinguished from the technician, who usually works under the direction of a professional.

Professional vs. Technician

The tenets used for the differentiation throughout the study are as follows:

Professional Level: Work that involves the exercise of professional judgment, frequently based on knowledge acquired through higher learning, generally non-routine in character. The term implies one who can plan, perform, and/or direct all such operations in the category; this person is responsible for work performed by those under him.

Technician Level: Work that is primarily routine, of a technical nature, often demanding a higher degree of skill, done under the direction

*First report: "Professional Aspects of Surveying and Mapping" dated October 24, 1955; published as Paper #921, Journal of Surveying and Mapping Division of ASCE, Vol. 82, No. SU 1, March 1956.

of a professional person who is responsible for its outcome. Such work is preprofessional when performed by a professional trainee who, having completed courses of specialized intellectual instruction and study, is seeking to attain professional status.

It might be appropriate to state that such a differentiation between professional and technician had not previously been made, but that its acceptance upon publication was unanimous, indicating that such is a very natural pattern of human behavior. Similarly, while no comprehensive classification of surveying-mapping activities had ever been published, the six categories shown met with general approval as well. The Task Committee submits this Classification Chart as part of its present final report. (See Appendix D.)

### C. Interim Report (1956): What in Surveying is Engineering*

Having completed the initial phase of the study, it became necessary to determine which of the six categories of activity are properly engineering activity. In October 1956, the Task Committee (Interim Report) listed its findings, as follows:

1. Land or Property Surveying (Cadastral) was stated to be separate and distinct from engineering, as determined from the official pronouncements of two groups:
   a. In 1948, the statement of the National Council of State Boards of Engineering Examiners (NCSBEE). (See Appendix A.)
   b. In 1952, the resolution of the National Society of Professional Engineers (NSPE). (See Appendix B.)
2. Engineering Surveys (for Design and Construction), because widely recognized as engineering, were identified as engineering;
3. Geodetic Surveying, Geodetic Engineering, or Geodesy was listed as engineering work in nearly its entire scope;
4. Cartographic Surveying, Cartographic Engineering, or Map and Chart Surveying was called engineering because so determined by the NCSBEE, the NSPE, and by a 1952 statement of the ASCE Board of Direction, as also because so adjudged generally by various state boards of engineering registration. (See Appendices A, B, and C.)
5. Aerial Survey Services (adjunct services not necessarily linked to photogrammetric mapping) were listed as non-engineering;
6. Cartography (map compilation from other than original surveys, map finishing, map reproduction) was listed as non-engineering.

#### Reaction of the Profession

Efforts to publicize these findings widely resulted in many responses from all parts of the United States. The land surveying statement caused by far the greatest discussion, with many groups and individuals strongly endorsing the stated view and with just as many others objecting thereto with equal vigor. Many analyses were made by land surveying groups, state and regional, but no general agreement was found to exist among them.

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*"Interim Report of the Task Committee on Status of Surveying and Mapping" of October 18, 1956, published in Civil Engineering of March 1957.

At this point, the American Congress on Surveying and Mapping (ACSM) became greatly interested and attempted to act as spokesman for land surveyors throughout the nation. At the suggestion of ACSM, Mr. Victor H. Ghent, land surveyor from Virginia, became an associate member of the Task Committee to act as ACSM liaison and to offer counsel in the deliberations. Mr. Ghent's aid is hereby gratefully acknowledged.

### D. Second Interim Report (1957): Modification re Land Surveying

With a fairly unified opinion across the country concerning the categories II through VI, but with a general lack of accord on category I, Land or Property Surveying (Cadastral), the report of October 1957 (Second Interim Report) of the Task Committee* was a restatement of its October 1956 findings, with a single exception. The change, concerning category I, was this statement:

> We find that more than half of the profession (including a national committee of surveying teachers) believe that Category I (Land Surveying-Cadastral) should continue to be regarded as a branch of civil engineering. . . We must therefore retract the recommendation of 1956 that land surveying be regarded as an activity separate and distinct from engineering.

With an unsettled question of such magnitude facing it, the Task Committee immediately presented (in form of an Appendix attached to the Second Interim Report) a partially developed thesis that would "retain" land surveying as a part of engineering. There began simultaneously a severe scrutiny by the Task Committee of all the reasons for retaining any part of surveying within the domain of engineering, especially for retaining land (property) surveying. The present report is the result of this scrutiny.

### E. Findings of the Present Report

Primary and basic attention was given to the fundamental question, "Does the practice of Surveying and Mapping as defined and categorized by the Committee constitute the practice of Professional Engineering?" Two facets of the problem were seen to be important: (1) recognition by the engineering profession, and (2) recognition by the legally constituted bodies, i.e., the various state laws and boards of professional licensing.

A review of the registration laws for professional engineers in the country indicates that a uniform and clear-cut decision has not been made. Some states, such as Pennsylvania, specifically include surveying (and mapping) as a part of the basic definitions of professional engineering practice; others have no reference to surveying-mapping in their laws; and in still other states, opinions by Attorney Generals have excluded all or parts of the Surveying profession from engineering and the requirement for licensing.

Since a lack of uniformity of state laws and rulings exists, the Task Committee felt that the basic definition and resolution of the professional status of surveying and mapping should emanate from the engineering profession itself.

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*"Second Interim Report of the Task Committee on Status of Surveying and Mapping" of October 18, 1957, not published but rather widely distributed by the Task Committee.

When the engineers have placed surveying and mapping in its proper professional position, a positive statement can be made to the licensing boards to attain legal recognition.

As a result of thorough deliberation and widespread consultation during the past year, the Task Committee feels that it is ready to present in this final report, certain findings on matters not covered in the prior interim reports. The findings are followed by a series of conclusions, and concomitant recommendations. The recommendations collectively constitute, in effect, a policy position for ASCE as principal spokesman for the civil engineering profession, as well as a program of action for state registration boards, engineering schools, ASCE's Surveying and Mapping Division, other professional societies, and individual engineers and surveyors throughout the country.

## Basic Considerations

From a fundamental point of view, the practice of engineering includes the use and recognition of the properties of matter and the sources of power in nature to provide tools, structures, machines, and conveniences useful to man. This broad scope of activity demands the professional services of persons schooled and skilled in the basic laws of nature and materials to successfully apply engineering principles. The Committee concludes that the application of the engineering concepts of mathematics, astronomy, mechanics, physics, and human management as practiced by persons engaged in activities defined in categories I, II, III, and IV of this report constitutes the practice of professional engineering. The investigation, planning, design, and responsible supervision of surveying operations, the construction of surveying equipment and/or systems, and the location, delimitation, and delineation of natural and physical features on the surface of the earth fulfill the requirements for engineering practice. The exercise of these responsibilities does require higher and professional education which the Committee believes must be satisfied by the completion of an engineering curriculum in a college or school having adequate equipment, resources, and professional instructors to provide at least a four-year program.

## Re Land Surveying

The place in engineering of our category I, Land Surveying (Property, Cadastral), is the subject of greatest controversy throughout the country and of greatest concern to this committee. The principal facts relevant to the matter seem to be:

1. A substantial majority of the civil engineering profession throughout the United States firmly believe categories II, III, and IV to be engineering.
2. However, with regard to category I, probably a majority of the profession feel that property surveying should be considered engineering and be "retained" within the branch of civil engineering. Many others believe that this category of work, while admittedly fully professional in nature, should be splintered off from engineering and be allowed to form into a separate professional group.
3. Probably a majority of private-practice property surveyors are also licensed (registered) as professional engineers, which seems to work out very well in practice, as both capabilities are required on many projects and, in any case, they tend to be complementary activities.

4. Others in private practice not so dually licensed usually find it necessary, in order to stay in business, to combine property surveying with certain auxiliary jobs that are generally considered to be engineering, e.g., subdivision development and construction layout.

The Task Committee believes, so far as the surveying and measurement sciences are concerned, that property surveying in the future will necessarily become increasingly more precise and complex, and will necessarily utilize geodetic, photogrammetric, electronic, and other advanced procedures. The Committee feels that the measurements made to ascertain the size and shape of the earth, as well as those to ascertain a distance between two points three hundred feet apart, are part of the same science. Similarly, surveying for the topographic plan for a 2-acre plot is part of the same science as mapping an entire State, although the specific techniques be different.

The Task Committee therefore advocates that the practice of property surveying, (usually referred to as land surveying in state registration acts), be considered to be an integral part of the surveying and mapping complex, and consequently of engineering. As a corollary, the Task Committee also advocates that a basic engineering education, preferably with some emphasis in the surveying and mapping sciences, should be prerequisite for all land surveyors of the future, as it should be also prerequisite for those who specialize in any other categories of surveying and mapping.

While admitting that property surveying and survey engineering are thus basically akin, identified in fact, the Task Committee here points out an additional important requirement for an engineer engaged in property surveying: a knowledge of property law and of local conditions. As has been established, all who wish to practice property surveying should be basically engineers (and should be equipped with the B.C.E degree or equivalent) because of the similarity of the knowledge and tools needed for both, and there should be no need for a separate L.S. examination and registration law.

It is most important, however, for all to recognize the peculiar nature of property surveying, which demands a specialized knowledge of property law and of local conditions. Because of the particular conditions that exist in many states in regard to land surveyors, platting laws, recording laws, etc., it is felt that each state must work out for itself the most practical methods of transition from land surveyor and professional engineer licenses to the single professional engineer license.

We envision that in the future it will be imperative that engineers be very careful, therefore, in judging their own competency to practice property surveying. This will require a renewed sense of ethics within the profession, but we are strong in the belief that without such a proper ethical basis a profession cannot exist.

## Re Photogrammetry

In view of the past controversies regarding the place of photogrammetry in topographic surveying and mapping, and in engineering, it is felt desirable to repeat here in some detail the views of the Task Committee on this matter.

It is the Committee's judgment that the use of photogrammetry involved in making a topographic plan or map, for example, is engineering work. However, certain adjunct aerial survey services (e.g., obtaining aerial photographs, etc.) in themselves are regarded as non-engineering. The findings of the Task Committee regarding photogrammetric activity are simply stated in the

Interim Report: "The photogrammetric methods of Categories I, II, III, and IV are engineering procedures by reason of their being operations of an engineering project, e.g., the preparation of a topographic map."

Certain difficulties seem to surround this concept of photogrammetry as a procedure, for some persons would have the method divorced from engineering and become a profession by itself.

It is the view of this Committee that the topographic plan or map, aside from its inherent value as an engineering instrument when completed, is itself a project that is engineered in its construction. The basic elements of lineal and angular measurements, and the selection of the proper instruments and procedures for each of the succession of operations beginning with horizontal and vertical control, must be commensurate with the purposes of the product. As the concept of measurement evaluation is essentially the basis of engineering, we hold that the topographic plan or map, whether or not produced mainly by means of photogrammetric surveying (or any other surveying method yet to be devised) rather than traditional ground surveys, is an engineered accomplishment.

Furthermore, it should be noted that a topographic plan or map is an engineering instrument, a basis on which engineering design is to be based, and that production of such topographic plan or map is undertaken for the value it will have for engineering planning and design for such as highways, dams, reservoirs, irrigation systems, drainage systems, industrial sites, subdivisions, etc. Vast sums of design and construction money will be expended on the basis of the map's information. Only in the measure that the plan is reliable can it be of any use, and it is manifestly impossible for the user to check the entire map for reliability without inordinate expenditure of time and effort. The reliability therefore is something that must be worked into the map by professionally accepted methods, competent and informed personnel, precision equipment, and (primarily) engineering planning and supervision at every stage of the process. It would be unwise to entrust the basic mapping of terrain and culture at any useful engineering scale to persons lacking a sense of plotting accuracy and of the implications of map error (and blunder).

It is well to remember that the use of aerial photographs in the surveying and mapping field has brought about the development of the science of photogrammetry. The original service offered by private practitioners was almost exclusively that of taking aerial photographs (classified as non-engineering) and it became common practice to obtain this service through competitive bidding. Later, when photogrammetric survey operations were added, competitive bidding was continued even when highly accurate, detailed surveys, and topographic plans and maps were a major part of the contract. The continuance of the competitive bidding practice also can be attributed to the relative newness of the photogrammetric methods (though European countries have utilized the basic principles for many decades), and the consequent reluctance of the public and of public bodies to risk money on untried procedures. The Committee is confident that persons who specialize in photogrammetric surveying procedures will welcome a clarification of their status and the recognition of their work as professional engineering, and that this should ultimately eliminate the practice of competitive bidding from this activity.

### Re New Umbrella Term

The Task Committee believes that Categories II, III, and IV clearly form the content of the "earth-measuring" sciences. We find, further, that

Category I, Land Surveying (cadastral) falls into this concept and, as recommended herein, should henceforth demand that its practitioners be engineers with specialized additional training and background. Thus we find that this field may well include geodesy, topography, hydrography, photogrammetry, engineering and construction surveying, property surveying, and the like.

Heretofore much reliance has been placed on the term "surveying and mapping" as an overall designation, although the term "cartography" was also used for a few years by Government agencies under instructions of the U. S. Civil Service Commission. We find that "surveying and mapping" as a designation is not only cumbersome, but falls short of conveying the proper meaning. The term "cartography" never found full acceptance among surveying-mapping practitioners in the United States.

The Task Committee therefore has attempted to find an appropriate name for the entire content of these "earth-measuring" sciences, a term which would serve to denote the entire field of Categories I, II, III, and IV. To date no agreement has been reached on a new umbrella term but the most appropriate names seem to be these three:

1. Survey Engineering, as proposed in an early report, meets with favor by many.
2. Geodetic Engineering, is the name acceptable to many others, although its basic weakness as a designation for the entire field stems from its being already the designation of one of the parts of the whole. European practice might be pointed to as a precedent for its use, however.
3. Geometronic Engineering, a term coined by Walter S. Dix, A.M., Am. Soc. C. E., and Secretary of A.C.S.M., meets with considerable favor by many persons although it is so new and untried that its use in this sense must be regarded as highly tentative.

The Task Committee offers these three terms for consideration without advocating any, recommending, however, that an umbrella designation is needed and should be used in referring to the work of the first four categories. Throughout the remainder of this report the term survey engineering is generally used, though such use is intended to be without prejudice to either of the other terms or to any other acceptable designation.

## Re Education

In the deeper study of surveying and mapping during the past year, two significant and pertinent trends have become apparent to the Task Committee:

1. Engineering as a profession is beginning, more than ever since its inception 150 years ago, to emerge clearly as a scientifically-oriented profession. No longer is it based primarily upon the art (the how-to-do), but is now assuredly founded on the principles of science. Educational institutions are rightly showing the way in this emergence of the new concept of engineering.
2. Surveying, concurrently, may be losing its place in the civil engineering curriculum, probably because:

   a) in the past elementary surveying has been taught mainly as an art, or how-to-do course, the type of course now being eliminated in many schools; and

b) unfortunately there is now not sufficient time available in a 4-year degree program to include the variety of subjects currently required in advanced surveying and mapping courses.

We find that educational facilities for geodetic surveying (Category III) and cartographic (topographic and hydrographic) surveying-mapping (Category IV), though recognized widely as being engineering, have been neglected in the United States to a serious degree. There are only a few engineering schools where the work is taught in the undergraduate curriculum despite today's drastic need for scientific manpower in these two fields specifically. Since the educational facilities for housing the body of professional knowledge are essential to making a profession, we believe that in this instance the lack of sufficient courses in surveying-mapping subjects is a serious impairment of the profession.

Perhaps worse off from the educational standpoint is property surveying, for preparation therefor is not generally regarded as an obligation of the colleges and universities. The legal aspects of property surveying are of the greatest importance, and surely warrant at the least an elective course in a few schools.

We take this occasion to sound a warning that we may soon be caught up in a shortage of intellectually competent persons able to carry on the necessary, even vital, function of geodesy, photogrammetry, topography-hydrography, and cadastral surveying on a professional level.

We believe that the present usual method of studying these important sciences, mainly self study while on in-service training assignments, will only result in shrinking the body of knowledge, in losing potentially high-caliber persons in the field, in stifling research in a vital science, and in lowering the stature of a professional field.

Specifically, where should such a body of knowledge be housed? Although a few persons would prefer to see the field of surveying and mapping splintered from engineering and be given a fresh start in the colleges of arts and sciences, it seems clear that a large majority of the civil engineering profession would much prefer that the engineering schools continue to be identified with all of the surveying and mapping sciences, on the grounds that in content and method they are most nearly engineering (as opposed to being simple or basic science). Some educators have included the geodetic sciences among the recognized engineering sciences.

The Task Committee believes that the engineering schools are the proper place for the study of the surveying and mapping, or geodetic sciences, especially in view of the enlightened shift of emphasis now current in these schools throughout the nation towards science-oriented curricula, plus the added factor of new knowledge of the geoid. The decrease of emphasis on the art of surveying in engineering curricula is not at all inimical to this recommendation; in fact, such decrease may be the very means of providing time for courses in geodetic, photogrammetric, cadastral, topographic and other such fields.

Actually the operation, care, and adjustments of surveying instruments should be handled as the work of technicians and we commend the colleges that give specialized training and/or two-year college programs for such work. However, engineers' responsibilities are more properly defined as the planning, direction and design of surveying and mapping operations.

The Committee agrees that the teaching of the highly specialized aspects of the survey (geodetic or geometronic) engineering field should be restricted to a relatively few universities. However, a course in basic surveying should be included in the curricula of all civil engineering colleges to provide fundamental concepts of geodetic relations, mensuration through the application of surveying techniques, the theory of errors, and the advantages, disadvantages, and restriction of various methods and techniques used in surveying and mapping practice.

## F. Conclusions and Recommendations

The following conclusions and recommendations are presented by the Task Committee for approval and action by the Surveying and Mapping Division and for appropriate action by the Society's Board of Direction:

1. That the overall definition of the field of surveying and mapping comprising six principal categories: a) land surveying; b) engineering surveying; c) geodetic surveying; d) cartographic surveying; e) aerial survey services; and f) cartography, all as shown in detail in the attached classification chart (Appendix D) be accepted, and that the difference between professional-level duties and technician-level duties as proposed in the classification chart be recognized.
2. That the first four of the six main categories comprising the overall field of surveying and mapping should continue to be regarded as engineering, these being land or property surveying, engineering surveying, geodetic surveying, and cartographic surveying; that these four categories should be considered as comprising the field of survey engineering (or geodetic engineering, or geometronic engineering), which in turn should be regarded as a branch of civil engineering; and that all State Registration Boards, engineering societies, and similar professional groups should recognize professional-level experience in this field as professional engineering experience.
3. That, with regard to education in this field,

   a) All fully accredited civil engineering curricula should include adequate instruction in basic surveying by qualified personnel.
   b) Some of the engineering schools throughout the country should provide an elective sequence of surveying and mapping subjects, available in the junior and senior years, totalling 16 to 20 semester hour credits, that would comprise, in effect, a major in survey engineering (or geodetic engineering or geometronic engineering) within the B.C.E. degree, or alternatively, a B.S. degree in such engineering;
   c) That at least one engineering school should offer graduate degree programs in the major specialties of the survey engineering field, such as: land surveying, geodetic, cartographic, and photogrammetric engineering;
   d) That all employers of professional-level surveying and mapping personnel be encouraged to assist those schools that are willing to establish the educational programs listed in (b) and (c) above, by recommending promising students for enrollment, by offering part-time employment to the students, and by employing graduates of such programs.

4. That at some appropriate time in the future, those who wish to engage in the practice of land surveying and related engineering work should first be required to qualify for a professional engineer (P.E.) license, and that ultimately the right to practice land surveying in any given area would be a moral right based on professional competence and the engineers' code of ethics, rather than a legal right based on separate registration for land surveying; and that all State Registration Boards be encouraged by all concerned to move toward the goal herein envisioned as rapidly as circumstances permit.
5. That all national, state, and local societies or associations of engineers and surveyors be encouraged to cooperate for the purpose of bringing about as rapidly as may be practicable, the ultimate situations contemplated in several of the above items.

. . . . . .

The Task Committee gratefully acknowledges the great assistance given by very many individuals and organizations who contributed their views and suggestions during the course of this study and in the formulation of this report. We urge them and all who are interested in the profession to work toward the furtherance of the report's objectives as a means of strengthening the profession in the critical years of the decades just ahead.

Respectfully submitted,

Alfred O. Quinn
George D. Whitmore
Brother B. Austin Barry, Chairman

Task Committee on Status
of Surveying and Mapping

Endorsed by the Executive Committee of the Surveying and Mapping Division, as Amended, October 15, 1958.

## APPENDIX I

Reference A

The Report of the Committee on Land Surveying of the National Council of State Boards of Engineering Examiners (NCSBEE) dated 1948 reads thus:

Definition of Land Surveying.

It is the opinion of this committee that the profession of land surveying comprises the determination of the location of land boundaries and land boundary corners; the preparation of maps showing the shape and areas of tracts of land into smaller tracts; including the layout of roads and streets, and rights of way of same, to give access to smaller tracts; and the preparation of official plats or maps of said land subdivisions, in compliance with the laws of the states in which the work is done.

The profession of land surveying also includes the preparation and interpretation of land descriptions for incorporation in deeds, leases and

other legal documents, and the application and interpretation of U. S. General Land Office (now the Bureau of Land Management) and court decisions, as such decisions relate to original surveys and resurveys.

Land Surveying does not include engineering surveys, such as those required for the planning and construction of railroads, highways, airports, utility lines and bridges, although the determination of the boundaries of the lands to be used for such engineering construction and the preparation of the legal descriptions of same is land surveying and not engineering surveying.

The surveying necessary for the preparation of a topographic map is engineering surveying and not land surveying.

Reference B

Resolution #1-52 submitted by Land Surveyors Committee (NSPE) 1952

WHEREAS, it has long been held in this country that surveying is a form of engineering; and
WHEREAS, there necessarily exists a close relationship between the professions of surveying and engineering; and
WHEREAS, the profession of surveying itself involves both land or boundary line surveys and engineering surveys; and
WHEREAS, the line of demarcation and the responsibility for the performance of these functions of the surveyor have been a source of doubt and question, often to the detriment of those concerned; and
WHEREAS, A Committee on Land Surveying of the National Council of State Boards of Engineering Examiners has officially propounded reasonable definitions and divisions of responsibility in this regard;
THEREFORE BE IT RESOLVED THAT:
The Land Surveyors Committee of the National Society of Professional Engineers urge that the Board of Trustees of said National Society

(a) endorse said report of the National Council of State Boards of Engineering Examiners, a copy of which is hereto attached;
(b) urge its member State Societies to promote the use and adoption of said report by their State Registration Boards; and
(c) combine its influence and prestige with other interested organizations to promote a uniform, high level, surveyors' registration act throughout the states of this country, with a view toward qualifying registered surveyors in general for membership in the National Society of Professional Engineers.

Reference C

AMERICAN SOCIETY OF CIVIL ENGINEERS

Surveying and Mapping Division

Draft of a Resolution submitted by the Executive Committee of the Surveying and Mapping Division to the Board of Direction of the American Society of Civil Engineers, February 16, 1952, and passed by the Board of Direction at the New Orleans meeting on March 3, 1952.

WHEREAS: the U. S. Civil Service Commission has decreed, in effect that in the operations of the Government's surveying and mapping agencies there is no work that can be considered to be engineering; and

WHEREAS: surveying of all types, and particularly surveying for the purpose of providing data for the production of maps (including geodetic, topographic, hydrographic, and cadastral surveying, as well as surveying techniques utilizing photogrammetry and electronics) have long been considered to be a branch of civil engineering; and

WHEREAS: the Civil Service Commission's order may ultimately affect the standing within the engineering profession of many engineers outside of government service, including members of the faculties of educational institutions, members of private-practice organizations, and engineer employees of state, county, and principal governments; and

WHEREAS: it is believed that a clear statement on this question by the recognized leaders of the civil engineering profession is necessary before any organization can hope to challenge successfully the Civil Service Commission as to the justice and wisdom of its edict;

NOW THEREFORE BE IT RESOLVED THAT:

in the opinion of the Board of Direction of the American Society of Civil Engineers, the planning, execution, and direction of the professional surveying activities that are necessary for the production of the Government's standard series of maps and charts, as well as similar work elsewhere, are professional engineering; and that the public interests which are dependent on the quality, consistency, and economy of such work will be best served if it is directed and performed, as much as possible, by professional engineers having appropriate qualifications.

Reference D

Definition of Professional Positions

As a guide to the terms used for designating the several professional positions in the preceding outline, it is thought advisable here to include certain definitions. These accord generally with the accepted definitions given in the ASCE Manual No. 34, "Definitions of Surveying, Mapping, and Related Terms" 1954, but are altered somewhat to describe more clearly the particular job function envisioned in this outline.

Land or Property Surveyor determines location of land boundaries; prepares maps showing shapes and areas of land; divides land into smaller tracts, including layout of roads and streets and rights-of-way for same to give access to smaller tracts; prepares official plats or maps of such land subdivisions; prepares and interprets land descriptions for incorporation in deeds, leases, etc.

Survey Engineer obtains information for planning or developing an engineering project and estimating its cost, often recording such information in form of an engineering map or plat.

Geodetic Surveyor (or Engineer) plans, performs, or supervises high-accuracy surveys as well as the computations and adjustments thereof, including such as triangulation, traverse, precise leveling, and astronomic observations, such surveys being of a magnitude that the required accuracy and precision can be obtained only through processes that involve figure and size of the earth.

Reference D

CLASSIFICATION CHART FOR SURVE

| | Professional Level*** | Technician or Pre-Professional Level**** |
|---|---|---|
| **I. Land or Property Surveying (Cadastral)** | | |
| A. Property and Boundary Surveys* | Land Surveyor | Instrumentman |
| B. Subdivision Surveys and Plats* | | Computer |
| C. Public Lands Surveys* | | Draftsman |
| D. Surveys for Plans and Plats* | | Tapeman |
| 1. Architectural (Building-Site) Surveys | | Rodman |
| 2. Tax Maps | | |
| **II. Engineering Surveys (for Design and Construction)** | | |
| A. Design Data Surveys (including Route Surveys)* | Survey Engineer | Instrumentman |
| 1. Control, Horizontal and Vertical | | Computer |
| 2. Culture and Topography | | Draftsman |
| 3. Profiles and Cross-Sections | | Tapeman |
| B. Construction Surveys* | | Rodman |
| 1. Layout Surveys | | |
| 2. Quantity and Measurement Surveys | | |
| 3. "As-Built" Surveys | | |
| a. Utility Surveys | | |
| C. Mine Surveys | | |
| **III. Geodetic Surveying, Geodetic Engineering, or Geodesy (not to be confused with precise plane surveying)** | | |
| A. Control Surveys, First- and Second-Order Accuracy** | Geodetic Surveyor or Geodetic Engineer Mathematician | Instrumentman |
| 1. Horizontal: triangulation, traverse, and electronic trilateration | | Observer |
| 2. Vertical: spirit and trigonometric leveling | | Computer |
| B. Geodetic Astronomy | | Gravimetric Operator |
| C. Gravity Surveys, Magnetic Declination Surveys, Figure-of-the-Earth Studies | | Recorder |
| | | Signalman |
| | | Tapeman |
| | | Rodman |
| **IV. Cartographic Surveying, Cartographic Engineering, or Map and Chart Surveying (surveys for constructing original maps and similar products)** | | |
| A. Control Surveys, Third- and Fourth-Order Accuracy** | Topographic Engineer | Plane-Table Operator |
| 1. Horizontal | Hydrographic Engineer | Instrumentman |
| 2. Vertical | | Observer |

* Photogrammetric procedures used when applicable on these and other activities.

** Electronic measuring procedures used when applicable on these and other activities.

FOR SURVEYING AND MAPPING

| | Professional Level*** | Technician or Pre-Professional Level**** |
|---|---|---|
| B. Topographic-Planimetric Surveys and Maps* | Photogrammetric Engineer | Computer |
| 1. Photogrammetric Aero-Triangulation | Survey Engineer (Control) | Recorder |
| 2. Mapping Surveys | Geodetic Surveyor | Draftsman |
| a. Ground-Survey Methods | or | Tapeman |
| b. Photogrammetric Methods | Geodetic Engineer | Rodman |
| 3. Field-Edit Surveys of Photogrammetric Compilations | | Stereo-Plotter Operator |
| C. Hydrographic Surveys** | | Observer |
| 1. Soundings: fathometer, hand-lead, sounding pole | | Recorder |
| 2. Sounding Fixes: three-point, electronic | | Computer |
| 3. Wire-Drag Surveys | | Draftsman |
| 4. Tidal and Current Surveys | | Leadsman |
| V. Aerial Survey Services | | |
| A. Aerial Photography | Photogrammetrist | Photographer |
| 1. Photo-Interpretation | Photo-Interpreter | Photo-lab Technician |
| B. Electrical Measurements for distances and position fixes (shoran, etc.) | Electronic Engineer | Photo Analyst |
| C. Airborne Magnetometer Surveys | Mathematician | Computer |
| D. Radar-Altimeter Profiles and Elevations | Geophysicist | Electronic Technician |
| | | Magnetometer Operator |
| | | Radar-altimeter Operator |
| VI. Cartography (not requiring original surveys) | | |
| A. Map Design | Cartographer | Map Compiler |
| B. Compilation derived from existing source data | Geographer | Mosaicker |
| 1. Evaluation of Maps and Other Source Data | Map Editor | Modeler |
| 2. Nautical and Aeronautical Charts, Topographic and Planimetric Maps, Special-Purpose Maps, etc. | | Engraver |
| 3. Photomaps and Mosaics | | Lithographer |
| 4. Relief Maps and Models | | |
| 5. Radar-Prediction Charts | | |
| C. Map Editing | | |
| D. Map Reproduction | | |
| 1. Engraving or equivalent | | |
| 2. Lithography | | |

*** See definitions following this outline. Titles listed are intended to be illustrative, not inclusive.

**** Including some which are normally skilled craftsmen but which sometimes, by reason of special training, are properly considered technicians, e.g., rodman, tapeman, leadsman, signalman, etc.

Survey Engineer (Control) plans, performs, or supervises surveys and computations of horizontal and vertical measurements involving complex network adjustments, etc.

Topographic Engineer plans, performs, or supervises the construction of topographic maps of any scale, contour interval, or accuracy specification, including all surveying procedures and calculations required for such map construction; determines when and whether ground or photogrammetric surveys or various combinations thereof shall be used.

Photogrammetric Engineer or Photogrammetrist plans, performs, or supervises use of photogrammetric instruments and techniques in conjunction with various aspects of surveying, mapping, resource surveys, and the design of photo-interpretation systems.

Cartographer plans construction and compilation of charts and maps of small scale; assembles, evaluates, selects, and directs plotting of data therefor.

Map Editor performs many functions of the cartographer; especially designs form and content of maps; designs criteria for symbolization and nomenclature; reviews manuscript maps as to accuracy, completeness, correctness, and conformity with established standards.

The titles mathematician, electronic engineer, geographer, geophysicist, etc., are not defined here specifically, since they are primarily titles of persons in allied professions whose work only incidentally is in the field of surveying and mapping.

## APPENDIX II

Excerpts from the minutes of the ASCE Board of Direction in Los Angeles, Calif.:

### February 1959 meeting

The Board VOTED the following actions with regard to the Final Report of the Task Committee on Status of Surveying and Mapping, attached as Exhibit 9:

(1) To adopt as Society policy the statement:

> The American Society of Civil Engineers, on the basis of thorough studies carried out by a Task Committee on the Status of Surveying and Mapping, declares that the following four major categories in the field of activity commonly designated as surveying and mapping are a part of the Civil Engineering profession:
>
> I. Land Surveying
> II. Engineering Surveying
> III. Geodetic Surveying
> IV. Cartographic Surveying
>
> These categories are described in Reference D of the Appendix to "The Status of Surveying and Mapping, Final Report, Task Committee on Status of Surveying and Mapping.
>
> Further, the Society declares that professional and technician positions within these categories should be classified according to the chart, which is a part of the previously mentioned Reference D of the Task Committee's Final Report.

(2) To refer the last paragraph of the above statement to the Committee on Membership Qualifications and the Committee on Professional Practice for study and report to the Board on appropriate implementation procedures in the MQC and the Local Qualifications Committees.

(3) To refer the declaration "That fully accredited civil engineering curricula should include adequate instruction in surveying by qualified personnel" to the Committee on Engineering Education for study and report to the Board at the earliest opportunity with regard to detailed statements and implementation.

(4) To refer the declaration "That state engineer examination boards should give appropriate recognition to professional level experience in surveying and mapping" to the Committee on Registration of Engineers for study and report to the Board at the earliest opportunity with regard to detailed statements and implementation.

Journal of the

SURVEYING AND MAPPING DIVISION

Proceedings of the American Society of Civil Engineers

CONTENTS

DISCUSSION

## HIGHWAY AND BRIDGE SURVEYS: PRELIMINARY SURVEY[a]

### Closure by Committee on Highway and Bridge Surveys

COMMITTEE ON HIGHWAY AND BRIDGE SURVEYS.—Mr. White's discussion is most welcome. It brings to the Committee's writing and editing process an additional experienced viewpoint and helps assure higher quality in the finished work.

Most of the changes advocated by Mr. White deserve comment to prevent certain extreme interpretations that he has read into the original text.

First, the expression "those who would misuse information for financial advantage" does not describe property owners as a group or class of people. Rather than appear to impute dishonesty to property owners we should state that aerial mapping prevents premature or erroneous disclosure of the details of probable location.

Second, it is straining the context to suggest that by mentioning the concealment feature the chapter "openly advocates secrecy in government." To avoid such an interpretation, we should call the act by its right name, security. Security is an established principle in our democratic process, ably defined and defended in our courts and in our public forums.

Third, Mr. White appears to state that most state highway departments can be expected to do their own photogrammetry, and that in a few years commercial photogrammetrists will cease to perform a major proportion of aerial mapping for highways. He asserts that the chapter soon will be outdated because it states, "A few state highway departments have their own photogrammetry departments . . .", and "Most organizations rely upon the commercial air mapping companies . . ." .

At present, fewer than twenty states perform either aerial photography or stereocompilation or both, with their own forces. The number having a complete facility, let alone sufficient capacity to do all required mapping themselves, is much smaller. Thus, in clarification of the statements in the first paragraph on page 4, "A few" might be changed to "Several", and "Most . . . rely upon . . . air-mapping companies" might be changed to "Most . . . procure part or all of their maps through . . . air-mapping companies."

Fourth, Mr. White takes issue with the definition of the strip map as a plotting on a continuous roll of detail paper. Such a definition in a Manual would appear to render "illigitimate" all strip maps not on continuous rolls, he states, and hence "there are probably more illegitimate than legitimate strip maps prepared." In our final editing, we should of course reassure the readers that other forms of strip maps are in good practice. As to the relative numbers of different kinds of strip maps, Mr. White could be possibly right.

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a. Proc. Paper 1697, July, 1958, by the Committee on Highway and Bridge Surveys.

And he's right about deleting "conventional" where it precedes the phrase "ground survey method."

# HIGHWAY AND BRIDGE SURVEYS: PRELIMINARY BRIDGE SURVEYS[a]

Discussions by R. Robinson Rowe, Woodland G. Schockley, John A. Focht, Jr., David M. Greer, Ralph F. Reuss, and E. J. Zegarra

R. ROBINSON ROWE,[1] M. ASCE.—The statement (footnote p. 1842-1) that this paper will form the basis for a chapter in a manual may answer the writer's question on scope. The reference in the first paragraph to "land and bay bottom" and the character of water crossings exemplified in all six figures is strong implication that the original scope was "bay crossings". Beginning at page 1842-10, however, there are occasional references to rivers and other inland waters, which indicates a change in scope after the report had been partly written. Presumably this broader scope will invoke considerable revision during the conversion to manual form.

Using this interpretation of the scope, it is suggested that the hydrographic surveys (p. 1842-10 et seq) should include brief treatment of additional topics:

1. Evidence of trend toward aggradation or degradation
2. Evidence of significant drift
3. Relation of private property to backwater

Degradation and aggradation may be slow or reciprocal processes; but large trends in either direction cannot be ignored. Drift is significant if it may govern the spacing of piers or elevation of underclearance above flood stage. Backwater above a bridge constriction may make a prima facie case for damage claims out of proportion to saving in bridge cost.

It is also noted that the scope, broadened by this interpretation, still excludes grade-separation bridges. Except for "Hydrographic Surveys", most of the text is applicable to this progressively more important field in bridge engineering. Either this field should be specifically excluded, or the text should be adapted to a positive inclusion.

Including grade-separation bridges, more might be said of mapping underground utility facilities, both by detectors in the field and record searches in the office.

WOODLAND G. SHOCKLEY,[2] F. ASCE.—The Committee is to be commended for their presentation of guides for preliminary bridge surveys, particularly those for overwater crossings. However, the writer, as a soil mechanics

a. Proc. Paper 1842, November, 1958, by the Committee on Highway and Bridge Surveys.

1. Principal Bridge Engr., Calif. Div. of Highways, Sacramento, Calif.
2. Asst. Chf., Soils Div., U. S. Army Engr. Waterways Experiment Station, Vicksburg, Miss.

engineer, wishes to take issue with the Committee on the inclusion of the section on "Geological and Foundation Surveys" (except for the last portion, "Location of Test Sites"), on the grounds that these features fall outside the scope of surveying and mapping activities. This is not to say that these features are not important in preliminary planning for bridges—they are, and the Committee correctly recognizes them as such. Nonetheless, geological and foundation surveys should be planned and executed under the supervision of qualified practitioners in these fields and not left to the surveyor or mapper, who may be poorly equipped to plan such programs and interpret the results. That the Committee recognizes the desirability of this approach is evident in their references to the services of the soils engineer and geologist.

The inclusion of an extensive section on subsurface exploration, comprising 40 per cent of the entire report, cannot but be construed by the surveyor or mapper that he has a responsibility for these features. If it is the intention of the Committee to provide helpful and educational information on subsurface explorations, one wonders why a similar section was not included on the design of the superstructure and the footings for the bridge.

However, by their own admission, the treatment of the items of subsurface exploration and sampling, laboratory testing, and pile testing, is incomplete. The writer feels that the lack of a more comprehensive treatment of these subjects may be more misleading than helpful. All that the surveyor or mapper needs to be told in a manual of this type is that there will be requirements for various kinds of subsurface exploration in connection with preliminary planning and that certain vertical and horizontal controls are necessary in connection with them. The section on "Location of Test Sites" adequately covers these requirements. The writer therefore urges strongly that the section on "Geological and Foundation Surveys," with the exception of the last portion, "Location of Test Sites," be deleted from the report.

JOHN A. FOCHT, Jr.,[1] A. M. ASCE.—This discussion was prompted almost entirely by the footnote to the title of the Proceedings Paper to the effect that it will form the basis for a chapter in a proposed ASCE Manual of Engineering Practice. Most of the material in Section 3 which is entitled "Geological and Foundation Surveys" does not belong in a manual on Bridge Surveys. The subsection "Location of Test Sites" does properly have a place in such a manual.

Prior to discussion of the technical aspects of Section 3, consideration should be given first to a few definitions. "Survey" has three definitions established in a dictionary:(1)

(1) To examine for some specific purpose, inspect or review carefully, review in detail
(2) To look at or consider, especially in a general or comprehensive way, review
(3) To determine the location, form, or boundaries of a tract of land by measuring lines and angles in accordance with the principles of geometry and trigonometry.

The third definition applies to the general field of surveying encompassed by the Surveying and Mapping Division as its purpose is stated in the ASCE

1. Chf. Design Engr., McClelland Engrs., Inc., Houston, Tex.

Official Register in part "to develop and promote the science and art of surveying and mapping."

The application of the term "survey" to studies of vehicular traffic, engineering salaries, soil conditions or public opinion falls under one of the first two definitions of the word depending upon the scope of study. Such studies do not constitute "surveys" in the same sense as the surveys discussed in Section 1 of the paper. By engineering usage, hydrographic surveys to determine tide and current conditions as well as bottom profiles have become accepted as conforming to the activity defined by the third definition above. The surveys of other factors affecting the design of highways and bridges, such as traffic surveys, economic surveys, geophysical surveys, or soil surveys, are not usually placed in the sphere of specialized interest of the Surveying and Mapping Division. These activities could be termed "studies" or "investigations" and the conflict between the different definitions of "survey" could be eliminated. In the remainder of this discussion "survey" will relate to the third dictionary definition.

The information which is developed by geological and foundation studies is of course very important in the preliminary design or planning stage of a bridge. The addition of the word "design" to the first sentence of Section 3 can be construed to shift this section from the field of activity of the Surveying Division to that of the Highway Division or perhaps the Structural Division. But should a chapter on foundation exploration be included in a manual on highway design, structural practice, or surveying? Dr. M. Juul Hvorslev, who is the author of the foremost reference on foundation exploration techniques, has written:(2)

> "The methods and equipment used in foundation exploration differ considerably, and it would not be easy, even for a group of specialists, to write a brief manual on foundation surveys which would be acceptable throughout the country. The preparation of such a manual will, of course, be still more difficult for people who are specialists in a field other than soil mechanics."

Dr. Karl Terzaghi, in a recent article in Civil Engineering,(3) wrote in his usual lucid way about soil exploration:

> "The percentage of significant information (obtained) may range from almost zero to close to a hundred percent, depending upon the qualifications of the man who prepared the subsoil exploration program."

Further reference to this article by Dr. Terzaghi is strongly recommended for anyone even considering the preparation of a manual to standardize techniques for soil mechanics investigations.

Section 3 contains a large amount of trivial detail but at the same time does not clearly establish many of the basic principles of foundation exploration. In addition, because of the inclusion of minor but controversial procedures and because of the omission of equally satisfactory methods, Section 3 would not have the endorsement of many practicing soils engineers. The inclusion of suggested procedures which are controversial in papers in the Proceedings, or even the Transactions, is not only acceptable but is in many instances desirable because of the discussions which develop. Controversial information in a manual, however, is improper and inadvisable. The usual engineer accepts the suggestions and recommendations in papers as personal opinion but will view those contained in a manual as having the weight of experience of the Society behind them.

Discussion in this and following paragraphs will illustrate only a few of the debatable aspects of Section 3. In the first place, which engineer on the design team should be responsible for planning of the foundation exploration—the surveyor, structural engineer, soils engineer, geologist? The implication of the last sentence in the second paragraph on page 1842-18 is that the surveying and mapping engineer should plan the exploration "utilizing the efforts of the structural engineer, the soils mechanics specialist, and perhaps the geologist on the more comprehensive explorations." It seems much more reasonable for the exploration to be planned by soils or geologic engineering personnel after extensive consultation with all other groups involved. The efforts of the surveying and mapping group should be directed towards the surveying control necessary to tie in and locate the borings, test pits, geophysical observations, and other exploration techniques.

The first paragraph under the heading "Index Piles and Load Bearing Tests" implies that the committee preparing the paper was aware that the discussion which follows does not pertain to surveying. The structural engineer and the soils engineer are the only two of the design group mentioned as having to consider the various factors involved. But by the time the section on "Laboratory Soil Testing" was prepared, the responsibility for the foundation investigation had again been taken out of the hands of the soils engineer because "the soils engineer should be consulted for guidance" in selecting the tests to be performed.

In the second paragraph under "Subsurface Borings," a "boring contract" is mentioned. Under some circumstances, there may not be a boring contract. An engineering organization might be retained to perform a complete foundation investigation including borings, laboratory testing, and analysis under an engineering contract. In a manual, the phraseology would imply that the borings would have to be done under a separate contract and such restriction is not necessary.

The introductory paragraph in regard to methods of sampling gives emphasis primarily to the drilling operations using casing and drop hammer. An obvious attempt was made to be general but success was not achieved. Two paragraphs, "Wash Boring" and "Rotary Drilling," present what is basically one technique and could have been discussed together under a single heading. In the "Wash Boring" paragraph the statement is made "Casing is required for this method (wash boring) in soft or cohesionless soils but may be omitted in some cohesive soils." This statement is incorrect. By the use of proper techniques (which incidentally are economical), casing can be omitted in almost every case except for locations in water. In these instances, the casing will often penetrate only a few feet into the soil.

Boring data alone, despite the technique used, is very seldom adequate for design. Some laboratory testing is nearly always performed if the foundations rest on soil. Therefore, the statement "If a spread footing is indicated for a certain pier, the boring information often will be adequate for design" is not correct. The general tone of the section on "Index Piles and Bearing Load Tests" would lead the reader to believe that laboratory tests on undisturbed samples provide little information of real usefulness. The same implication is made in the section on "Laboratory Testing." On all but the smallest structures, some laboratory testing should be performed even if only to determine the index properties of the soil and to check the field classifications. The boring information does provide the necessary information on soil stratigraphy and can supply a general indication of the strength and compressibility

characteristics of the soil. But laboratory tests on good undisturbed samples are required to develop specific quantitative data. Such data is required for design and for interpretation of test pile information.

The reliance on "the driving record of the dry spoon sampling—to indicate a good build-up in soil bearing capacity" can lead to trouble. Foundation designs based on sampler driving resistance can be underconservative in some cases and overconservative in others. The relative precision of soil strength or compressibility estimated from sampler driving data is one of the more controversial subjects in soil mechanics.

In conclusion, the geological and soil studies discussed in this paper are not "surveys" in accordance with the usually accepted definition of engineering surveying and mapping. The opinions expressed in the foregoing paragraph on a few of the disputable technical aspects of Section 3 are admittedly personal and, as previously stated, would not have been made except that the material in this paper is slated for use in a manual. Nevertheless, they do illustrate to a limited degree the variance of opinion on foundation investigations. All of these factors lead to only one conclusion,—the proposed Manual on Bridge Surveys should not include a section on geological and foundation studies other than to discuss the location control required for such investigations.

## REFERENCES

1. "Webster's New World Dictionary, College Edition," The World Publishing Co., New York, N. Y., 1957, p. 1468.
2. Personal correspondence.
3. Terzaghi, Karl, "Soil Mechanics in Action," Civil Engineering, February, 1959, Vol. 29, No. 2, p. 33.

DAVID M. GREER,[1] F. ASCE.—It is noted that this paper is intended for inclusion in a proposed ASCE Manual of Engineering Practice. The writer objects to such use of this paper in its present form.

Most of the matter included in Section 3 is not proper for inclusion in a manual of the Surveying and Mapping Division, since it does not relate to surveying (or mapping) in the ordinary sense of the word—indeed, not in the sense that has determined the membership of that Division. It does, however, relate directly to matters which fall within the province of the Soil Mechanics and Foundations Division of the Society; and it touches on some of these matters in such a way that it can come into direct conflict with members of that Division, in the proper practice of their profession. This is no more proper than it would be for the Soil Mechanics and Foundations Division to promote a manual on design of bridge foundations in which they specified the type of survey, and kind of surveying instrument that should be used in laying-out and determining elevations of borings.

Some of the statements contained in Section 3 of this proposed manual are, at the very least, controversial in nature; and actually constitute errors of fact.

1. Vice-Pres., Woodward-Clyde-Sherard and Associates, in Chg. of Montclair, N. J. office.

RALPH F. REUSS,[1] M. ASCE.—This progress report of the Committee on Highway and Bridge Surveys of the Surveying and Mapping Division, presents a very complete picture of all the factors which must be considered in preliminary surveys for bridge locations.

Publication of the procedures, some of which are controversial, as part of the manual would tend to specify acceptable methods of exploration, and exclude and minimize the importance of alternate methods of drilling and laboratory testing. In addition, the geological and soils studies are not surveys in the sense of the usually accepted definition of Engineering Surveying and Mapping. All factors considered, it is believed that the manual on bridge surveys should not include a section on Geological and Foundation Studies except to indicate the survey procedures for test boring location and control. There should, instead, be included a short section stating the complexity of the problem relative to soils and foundation studies and recommending that a competent engineer be employed to assist in the planning and analyses of the soils data. This would be more in keeping with the intent of the manual and would emphasize the importance of foundation studies, and the economy to be realized by an adequate study of foundation conditions.

The first three paragraphs of Section 3 followed by a statement that the soils and foundation engineer or section should be consulted would emphasize the importance of adequate soils studies and the need for experienced assistance in this phase of the project.

E. J. ZEGARRA,[2] M. ASCE.—An attempt has been made in the Progress Report for preliminary bridge surveys to include a comprehensive outline of the many data required for the basis of design. Among these data are the geologic and subsurface investigations which, as pointed out in Section 3, are "the most important portion of the preliminary stage". Fully half of the report is devoted to this stage of work, its scope, significance and ultimate use. In spite of this effort the subject has been sketchily and inadequately covered. Since the geologic and subsurface investigations are by themselves a large and special branch their inclusion within "surveys", as the term is generally understood, could not be properly treated. The subject has been oversimplified, generalized, and compacted to the point where it would be ineffective to point out its deficiencies. Many warning flags are raised and appropriate references are made to standard works, such as those of Hvorslev and Chellis, yet the entire subject fails to reach the clarity and usefulness required to plan or evaluate the steps involved in securing foundation design data. Each and every type of subsurface exploration has limitations and circumscribed use. Where these limitations are exceeded the method and its results are suspect. Even a simple shovel cut or a probing can be of use if the results are not pretentiously evaluated. A percussion core boring may be used to determine the expected length of penetration of a steel pile into the upper measures of a rock formation but it would not be used to determine the character and stratification of the stratum.

In the report it is stated that the results of borings may or may not be sufficient for final design. This is a preface to say that it might be advisable to make driving and loading tests on index piles. It is important to correct the

1. Partner, National Soil Services, Houston, Tex.
2. Soils and Foundation Engr., The M. W. Kellogg Co., New York, N. Y.

impression that a comprehensive and thorough subsurface investigation would still be inadequate or insufficient to formulate a basis of foundation design. It is true that some of the conclusions may be subject to confirmation by field tests and this is the case in friction piles for which driving and loading tests are usually required. Driving tests on index piles should, by the way, be conducted using equipment similar if not identical to that to be used on the final job since the test pile determines the length required to reach a certain resistance to penetration.

Although the bearing capacity of soils can be evaluated for practical purposes the frictional resistance of piles is still a tentative subject which must be confirmed by full scale pile tests. And if it were practical to make full scale loading tests on spread footings the ultimate bearing capacity could also be confirmed. Yet in the report the use of bearing load tests on plate, which of necessity are small, are placed in the same category of reliance as pile tests.

With respect to laboratory tests on soil samples the report recommends that these be made for large and complicated projects only if a review of data points to unusual conditions. It is inferred here that the "unusual" conditions may be evaluated without benefit of laboratory tests by mere visual inspection and classification.

In pointing out the shortcomings of section 3 of the report, the underlying intent in this discussion has been to suggest that such policy be abandoned and substituted by a more general and broad outline. It would be much more pertinent simply to specify the results desired from geologic and soil studies which are applicable to bridge design. And in this respect a large bridge is no different than many other large project. Primarily the foundations of a bridge require data for evaluation of bearing capacity of soils and rocks, estimates of magnitude and rate of settlement, shearing strength from which to predetermine approximate length and type of piles; active and passive pressure of soils and in some cases, stability analysis of slopes, embankments and even seepage studies. Whether a bridge is large or small the data required must be adequate for the design. In the case of small highway bridges the studies made for road design may be sufficient while for special conditions supplemental studies must be made. Special conditions would be disclosed in the general road investigations. For large projects the investigations are usually in stages. One, a general exploration to determine the broad features of soils and geology followed by a specific program in which the exploration and studies are directed specifically to elements of the project for which detailed and pertinent design information is required. Each of these stages employs boring methods and sampling devices suited to the type of soils and rocks. If there is one requirement which is essential to success, it is that the structural designer secure the services of the geologist and the soils specialist to plan, direct and supervise the pertinent studies. These studies are so important and valuable that they cannot be lightly included with surveys.

## PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Pipeline (PL), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW), divisions. Papers sponsored by the Department of Conditions of Practice are identified by the symbols (PP). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper number are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 1859 is identified as 1859 (HY7) which indicates that the paper is contained in the seventh issue of the Journal of the Hydraulics Division during 1958.

### VOLUME 84 (1958)

SEPTEMBER: 1750(IR3), 1751(IR3), 1752(IR3), 1753(IR3), 1754(IR3), 1755(ST5), 1756(ST5), 1757(ST5), 1758 (ST5), 1759(ST5), 1760(ST5), 1761(ST5), 1762(ST5), 1763(ST5), 1764(ST5), 1765(WW4), 1766(WW4), 1767 (WW4), 1768(WW4), 1769(WW4), 1770(WW4), 1771(WW4), 1772(WW4), 1773(WW4), 1774(IR3), 1775(IR3), 1776(SA5), 1777(SA5), 1778(SA5), 1779(SA5), 1780(SA5), 1781(WW4), 1782(SA5), 1783(SA5), 1784(IR3)[c], 1785(WW4)[c], 1786(SA5)[c], 1787(ST5)[c], 1788(IR3), 1789(WW4).

OCTOBER: 1790(EM4), 1791(EM4), 1792(EM4), 1793(EM4), 1794(EM4), 1795(HW3), 1796(HW3), 1797(HW3), 1798(HW3), 1799(HW3), 1800(HW3), 1801(HW3), 1802(HW3), 1803(HW3), 1804(HW3), 1805(HW3), 1806(HY5), 1807(HY5), 1808(HY5), 1809(HY5), 1810(HY5), 1811(HY5), 1812(SM4), 1813(SM4), 1814(ST6), 1815(ST6), 1816(ST6), 1817(ST6), 1818(ST6), 1819(ST6), 1820(ST6), 1821(ST6), 1822(EM4), 1823(PO5), 1824(SM4), 1825(SM4), 1826(SM4), 1827(ST6)[c], 1828(SM4)[c], 1829(HW3)[c], 1830(PO5)[c], 1831(EM4)[c], 1832(HY5)[c].

NOVEMBER: 1833(HY6), 1834(HY6), 1835(SA6), 1836(ST7), 1837(ST7), 1838(ST7), 1839(ST7), 1840(ST7), 1841(ST7), 1842(SU3), 1843(SU3), 1844(SU3), 1845(SU3), 1846(SU3), 1847(SA6), 1848(SA6), 1849(SA6), 1850 (SA6), 1851(SA6), 1852(SA6), 1853(SA6), 1854(ST7), 1855(SA6)[c], 1856(HY6)[c], 1857(ST7)[c], 1858(SU3)[c].

DECEMBER: 1859(HY7), 1860(IR4), 1861(IR4), 1862(IR4), 1863(SM5), 1864(SM5), 1865(ST8), 1866(ST8), 1867 (ST8), 1868(PP1), 1869(PP1), 1870(PP1), 1871(PP1), 1872(PP1), 1873(WW5), 1874(WW5), 1875(WW5), 1876 (WW5), 1877(CP2), 1878(ST8), 1879(ST8), 1880(HY7)[c], 1881(SM5)[c], 1882(ST8)[c], 1883(PP1)[c], 1884(WW5)[c], 1885(CP2)[c], 1886(PO6), 1887(PO6), 1888(PO6), 1889(PO6), 1890(HY7), 1891(PP1).

### VOLUME 85 (1959)

JANUARY: 1892(AT1), 1893(AT1), 1894(EM1), 1895(EM1), 1896(EM1), 1897(EM1), 1898(EM1), 1899(HW1), 1900(HW1), 1901(HY1), 1902(HY1), 1903(HY1), 1904(HY1), 1905(PL1), 1906(PL1), 1907(PL1), 1908(PL1), 1909(ST1), 1910(ST1), 1911(ST1), 1912(ST1), 1913(ST1), 1914(ST1), 1915(ST1), 1916(AT1)[c], 1917(EM1)[c], 1918(HW1)[c], 1919(HY1)[c], 1920(PL1)[c], 1921(SA1)[c], 1922(ST1)[c], 1923(EM1), 1924(HW1), 1925(HW1), 1926 (PL1), 1927(HW), 1928(HW1), 1929(SA1), 1930(SA1), 1931(SA1), 1932(SA1).

FEBRUARY: 1933(HY2), 1934(HY2), 1935(HY2), 1936(SM1), 1937(SM1), 1938(ST2), 1939(ST2), 1940(ST2), 1941(ST2), 1942(ST2), 1943(ST2), 1944(ST2), 1945(HY2), 1946(PO1), 1947(PO1), 1948(PO1), 1949(PO1), 1950(HY2)[c], 1951(SM1)[c], 1952(ST2)[c], 1953(PO1)[c], 1954(CO1), 1955(CO1),1956(CO1),1957(CO1), 1958(CO1), 1959(CO1).

MARCH: 1960(HY3), 1961(HY3), 1962(HY3), 1963(IR1), 1964(IR1), 1965(IR1), 1966(IR1), 1967(SA2), 1968(SA2), 1969(ST3), 1970(ST3), 1971(ST3), 1972(ST3), 1973(ST3), 1974(ST3), 1975(ST3), 1976(WW1), 1977(WW1), 1978(WW1), 1979(WW1), 1980(WW1), 1981(WW1), 1982(WW1), 1983(WW1), 1984(SA2), 1985(SA2)[c], 1986 (IR1)[c], 1987(WW1)[c], 1988(ST3)[c], 1989(HY3)[c].

APRIL: 1990(EM2), 1991(EM2), 1992(EM2), 1993(HW2), 1994(HY4), 1995(HY4), 1996(HY4), 1997(HY4), 1998 (SM2), 1999(SM2), 2000(SM2), 2001(SM2), 2002(ST4), 2003(ST4), 2004(ST4), 2005(ST4), 2006(PO2), 2007 (HW2)[c], 2008(EM2)[c], 2009(ST4)[c], 2010(SM2)[c], 2011(SM2)[c], 2012(HY4)[c], 2013(PO2)[c].

MAY: 2014(AT2), 2015(AT2), 2016(AT2), 2017(HY5), 2018(HY5), 2019(HY5), 2020(HY5), 2021(HY5), 2022(HY5), 2023(PL2), 2024(PL2), 2025(PL2), 2026(PP1), 2027(PP1), 2028(PP1), 2029(PP1), 2030(SA3), 2031(SA3), 2032(SA3), 2033(SA3), 2034(ST5), 2035(ST5), 2036(ST5), 2037(ST5), 2038(PL2), 2039(PL2), 2040(AT2)[c]. 2041(PL2)[c], 2042(PP1)[c], 2043(ST5)[c], 2044(SA3)[c], 2045(HY5)[c], 2046(PP1), 2047(PP1).

JUNE: 2048(CP1), 2049(CP1), 2050(CP1), 2051(CP1), 2052(CP1), 2053(CP1), 2054(CP1), 2055(CP1), 2056 (HY6), 2057(HY6), 2058(HY6), 2059(IR2), 2060(IR2), 2061(PO3), 2062(SM3), 2063(SM3), 2064(SM3), 2065 (ST6), 2066(WW2), 2067(WW2), 2068(WW2), 2069(WW2), 2070(WW2), 2071(WW2), 2072(CP1)[c], 2073(IR2)[c], 2074(PO3)[c], 2075(ST6)[c], 2076(HY6)[c], 2077(SM3)[c], 2078(WW2)[c].

JULY: 2079(HY7), 2080(HY7), 2081(HY7), 2082(HY7), 2083(HY7), 2084(HY7), 2085(HY7), 2086(SA4), 2087 (SA4), 2088(SA4), 2089(SA4), 2090(SA4), 2091(EM3), 2092(EM3), 2093(EM3), 2094(EM3), 2095(EM3), 2096 (EM3), 2097(HY7)[c], 2098(SA4)[c], 2099(EM3)[c], 2100(AT3), 2101(AT3), 2102(AT3), 2103(AT3),2104(AT3), 2105(AT3), 2106(AT3), 2107(AT3), 2108(AT3), 2109(AT3), 2110(AT3), 2111(AT3), 2112(AT3),2113(AT3), 2114(AT3), 2115(AT3), 2116(AT3), 2117(AT3), 2118(AT3), 2119(AT3), 2120(AT3), 2121(AT3),2122(AT3), 2123(AT3), 2124(AT3), 2125(AT3).

AUGUST: 2126(HY8), 2127(HY8), 2128(HY8), 2129(HY8), 2130(PO4), 2131(PO4), 2132(PO4), 2133(PO4),2134 (SM4), 2135(SM4), 2136(SM4), 2137(SM4), 2138(HY8)[c], 2139(PO4)[c] 2140(SM4)[c].

SEPTEMBER: 2141(CO2),2142(CO2),2143(CO2),2144(HW3),2145(HW3), 2146(HW3), 2147(HY9), 2148(HY9), 2149(HY9),2150(HY9),2151(IR3), 2152(ST7)[c], 2153(IR3), 2154(IR3), 2155(IR3), 2156(IR3), 2157(IR3), 2158 (IR3), 2159(IR3), 2160(IR3), 2161(SA5), 2162(SA5), 2163(ST7), 2164(ST7), 2165(SU1), 2166(SU1), 2167(WW3), 2168(WW3), 2169(WW3), 2170(WW3), 2171(WW3), 2172(WW3), 2173(WW3), 2174(WW3), 2175(WW3), 2176 (WW3), 2177(WW3), 2178(CO2)[c], 2179(IR3)[c], 2180(HW3)[c], 2181(SA5)[c], 2182(HY9)[c], 2183(SU1)[c], 2184 (WW3)[c], 2185(PP2)[c], 2186(ST7)[c], 2187(PP2), 2188(PP2).

c. Discussion of several papers, grouped by divisions.

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# SU1

SEPTEMBER 1959 — 33 NO. SU 1
VOLUME 85 PART 2

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# NEWS OF THE SURVEYING AND MAPPING DIVISION OF ASCE


JOURNAL OF THE SURVEYING AND MAPPING DIVISION
PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

# DIVISION ACTIVITIES

# SURVEYING AND MAPPING DIVISION

Proceedings of the American Society of Civil Engineers

## NEWS

September, 1959

### PURPOSE OF THE SURVEYING AND MAPPING DIVISION
(Quoted from the Official Register)

"to develop and promote the science and art of surveying and mapping, to increase the use of surveying and mapping data, and to aid engineers by prescribing certain standards of accuracy and detail for specific surveys."

Approximately 1750 members of the American Society of Civil Engineers are currently enrolled in the Surveying and Mapping Division.

### NEWSLETTER REVIVED

The Executive Committee of the Surveying and Mapping Division has decided to revive the newsletter as a means of bringing specific news of the activities of the division to the membership. Professor Kenneth S. Curtis of Purdue University has accepted the responsibility of newsletter editor and he would like the support of all members in sending him worthy news items. The newsletter is one of the activities of the Publications Committee which is currently chairmaned by Carl M. Berry, Seattle, Washington, but which will be chairmaned by Professor Lawrence Perez of Pennsylvania State University after October, 1959.

### EXECUTIVE COMMITTEE - 1959

| | |
|---|---|
| Chairman: | Milton O. Schmidt (1960)<br>Professor of Civil Engineering<br>University of Illinois<br>Urbana, Illinois |
| Vice-Chairman: | Earle J. Fennell (1961)<br>Assistant Chief Topographic Engineer<br>U. S. Geological Survey<br>Washington, D. C. |

Note: No. 1959-33 is part of the copyrighted Journal of the Surveying and Mapping Division, Proceedings of the American Society of Civil Engineers, Vol. 85, SU 1, September, 1959.

Col. Carl M. Berry (1959)
Consulting Engineer
South Administration Building
Box 38, Boeing Field
Seattle 8, Washington

Arthur J. McNair (1962)
Professor of Civil Engineering
Cornell University
Ithaca, New York

Board Contact Member: Weston S. Evans, Sr.
Professor and Head of Civil Engineering
University of Maine
Orono, Maine

Secretary: Franklin R. Gossett
Assistant to the Director
U. S. Coast and Geodetic Survey
Washington, D. C.

## COMMITTEE CHAIRMEN - 1959

Administrative Committees:
Publications - Carl M. Berry
Research and Development - Roland H. Moore

Technical Committees:
City Surveys - George D. Whitmore
Control Surveys - Carl M. Berry
Definitions of Surveying Terms - Benjamin E. Beavin, Sr.
Highway and Bridge Surveys - Milton O. Schmidt
Land Surveys and Titles - Sol A. Bauer
Topographic Mapping and Photogrammetry - Daniel Kennedy
Status of Surveying and Mapping (Special Task Committee) - B. Austin Barry

See the Official Register for complete membership of committees.

## ASCE WASHINGTON CONVENTION - OCTOBER 19-23, 1959

Mr. Earle J. Fennell, Assistant Chief Topographic Engineer, U. S. Geological Survey, has scheduled a very interesting program for the October convention in Washington, D. C. with regard to the Surveying and Mapping Division. Mr. Fennell, who is Vice-Chairman of the Executive Committee, will preside.

### Wednesday, October 21, 1959

2:30 P.M. SURVEYING AND MAPPING PROBLEMS OF OUR 49th AND 50th STATES (Panel Discussion)
Moderator: To be announced
Panelists: -Franklin K. Van Zandt, U. S. Bureau of Land Management, Washington, D. C.

-Reynold E. Isto, U. S. Geological Survey, Fairbanks, Alaska
-Representatives from U. S. Coast and Geodetic Survey and U. S. Forest Service yet to be named.

3:45 P.M. MILITARY REQUIREMENTS FOR TOPOGRAPHIC MAPS
Colonel Frederick O. Diercks, Commanding Officer, Army Map Service, Washington, D. C.

4:15 P.M. CIVIL REQUIREMENTS FOR TOPOGRAPHIC MAPS
Robert H. Lyddan, Assistant Director, U. S. Geological Survey, Washington, D. C.

Thursday, October 22, 1959

8:45 A.M. LAND SUBSIDENCE OVER LARGE AREAS AS SHOWN BY HIGH ORDER LEVELING
A representative from U. S. Coast and Geodetic Survey

9:15 A.M. THE FUTURE OF RESEARCH IN THE FIELD OF SURVEYING AND MAPPING
Prof. William B. Snow, Rutgers University, New Brunswick, New Jersey

9:45 A.M. IMPLEMENTATION OF THE BOARD OF DIRECTION'S ACTION ON THE STATUS OF SURVEYING AND MAPPING IN THE CIVIL ENGINEERING PROFESSION (Panel Discussion)
Moderator: To be announced
Panelists: -Brother B. Austin Barry, Associate Professor, Manhattan College, New York, N. Y.
-Alfred O. Quinn, Chief Engineer, Aero Service Corporation, Philadelphia, Pa.
-George D. Whitmore, Chief Topographic Engineer, U. S. Geological Survey, Washington, D. C.

## ASCE - MANUALS OF ENGINEERING PRACTICE

More than three dozen technical manuals have been prepared and published by ASCE under the sponsorship of the various Technical Divisions. These can be ordered directly from the Headquarters of the Society (50% discount to members) and those which involve surveying and mapping are the following:

No. 10 TECHNICAL PROCEDURE FOR CITY SURVEYS $3.00
(Committee on City Surveys, Surveying and Mapping Div., Original edition 1934, Revised edition 1957)

No. 16 LAND SUBDIVISION $1.60
(Committee on Land Subdivision, City Planning Div., Original edition 1939, Currently being revised)

No. 20 HORIZONTAL CONTROL SURVEYS TO SUPPLEMENT THE FUNDAMENTAL NET
(Committee on Control Surveys, Surveying and Mapping Div., Edition 1940, Currently out of print).

No. 34 DEFINITIONS OF SURVEYING, MAPPING, AND RELATED TERMS $3.00
(Committee on Definitions of Surveying Terms, Surveying and Mapping Div., Original edition as Manual No. 15, 1938; Expanded and Revised 1954)
(Also available in cloth binding: Price $4.00; to members, $2.50)

Two other committees are hard at work on other manual compilations:

Manual on Highway and Bridge Surveys,
(Committee on Highway and Bridge Surveys, Surveying and Mapping Division)

Manual on Pipeline Location
(Committee on Pipeline Location, Pipeline Division, in cooperation with Surveying and Mapping Division)

## ADDITIONAL PROCEEDINGS PAPERS

In addition to the Proceedings Papers which were published in the Journal of the Surveying and Mapping Division and sent automatically to all ASCE members registered in the Division, there were two other papers published during 1958 which would be of interest:

#1574 PIPELINE LOCATION SURVEYS (Pipeline Div.)
#1668 ENGINEERING USES OF SONNE STRIP PHOTOGRAPHY (Pipeline Div.)

## Calendar of Coming Meetings

| | |
|---|---|
| October 19-23, 1959 | ASCE, Washington, D. C., Convention |
| March 7-11, 1960 | ASCE, New Orleans Convention |
| June 19-23, 1960 | ASCE, Reno Convention |
| October 9-13, 1960 | ASCE, Boston Convention |
| April 10-15, 1961 | ASCE, Phoenix Convention |
| October 16-20, 1961 | ASCE, New York Convention |
| February 1962 | ASCE, Houston Convention |
| May 1962 | ASCE, Omaha Convention |
| October 15-19, 1962 | ASCE, Detroit Convention |

## Early Transactions Volumes Obtainable

The feasibility of reproducing the first ten volumes of ASCE TRANSACTIONS (1872-1881) has been studied. It has been decided that these historic volumes could be reproduced at a cost that would permit a top price of $150 for the ten-volume set. If more than 100 engineers, or libraries, indicate an interest in obtaining such a set, the project will be undertaken. If the

endeavor is successful, other rare volumes of TRANSACTIONS will be reprinted.

Engineers interested in obtaining the ten-volume set should write to the Executive Secretary of ASCE, 33 West 39th Street, New York 18, N. Y.

## USE OF THE NEWSLETTER

You are urged to make use of this Division Newsletter for announcements, inquiries, personnel news, committee reports, surveys, and other items of interest to Division members. Please send these items to the editor:

PROFESSOR KENNETH S. CURTIS
School of Civil Engineering
Purdue University
Lafayette, Indiana

## STUDY OF THE METRIC SYSTEM IN THE UNITED STATES

The American Geophysical Union has appointed a "Committee on the Study of the Metric System in the United States" under the chairmanship of Floyd W. Hough. The information and questionnaire below and on the next page have been prepared by this committee and is presented for the benefit of interested ASCE members.

Bills for the exclusive adoption of the metric system in the United States have been more than once presented to Congress, but they failed, the principal reason being that the effective date proposed was entirely too soon after passage of the bill. An early effective date would undoubtedly work a severe hardship on the adult population not familiar with the metric system, and it would make obsolete a prohibitive amount of every-day items of weights and measures. A solution would appear to be a bill to make the metric system the only official system of weights and measures in the United States, effective in not less than one generation, 33 years, after passage of the bill. Following this action by the Congress, the grade schools and high schools would begin immediately to teach children the metric along with the English system and, during the transition period, would place more and more emphasis on the metric system. By the end of the transition period, the English system would still be taught, but the emphasis would be completely reversed from what it is today. In a generation, most items of equipment involving weights and measures normally become obsolete or worn out and are replaced. Also, persons engaged in professions and trades now using the English system exclusively would normally pass on to retirement during this period and would be replaced by a new generation thoroughly educated and trained in the metric system. A long transition period should result in a smooth change to this simplified decimal system under which 90 per cent of the world's people now live.

The attached questionnaire is directed to readers for the purpose of gathering statistical information to indicate the degree of interest in this matter. The metric committee of the American Geophysical Union will welcome any comments. Those submitting replies are urged to suggest solutions to difficulties which may be foreseen in the adoption of the metric system.

Editor's Note: Two very appropriate publications of the National Bureau of Standards are available from the Government Printing Office at nominal cost:

N.B.S. Miscellaneous Publication 214, UNITS OF WEIGHT AND MEASURE DEFINITIONS AND TABLES OF EQUIVALENTS (40¢)

N.B.S. Circular 593, THE FEDERAL BASIS FOR WEIGHTS AND MEASURES - A historical review by Ralph W. Smith (30 ¢)

AMERICAN GEOPHYSICAL UNION SPECIAL COMMITTEE ON THE STUDY OF THE METRIC SYSTEM IN THE UNITED STATES

## METRIC SYSTEM QUESTIONNAIRE

1. Indicate professional field of interest in the A.G.U._____

2. What approximate percentages of units used in your work are:

   Metric_____ British_____ Other_____

3. Would it be to your advantage if a complete conversion to the metric system could eventually be made? Yes_____ No_____

4. How long a period of time should be allowed for the conversion, in years?
   10_____ 20_____ 30_____ 40_____ 50_____ Longer_____

5. Should the centigrade system of temperature measurement be adopted?
   Yes_____ No_____

6. Do you believe that U. S. export trade is suffering due to the use of British units?
   Yes_____ No_____ No Opinion_____

7. Do you believe that the eventual adoption of the metric system is inevitable?
   Yes_____ No_____

8. In the event of a long time conversion to the metric system, do you believe that the cost would be prohibitive?
   Yes_____ No_____

9. In the event a Joint Committee were established to study the problem, circulate questionnaires, accumulate statistics, and report, it should be sponsored by:

   (Check one) Professional Societies_____ Industry_____
   Educational Institutions_____ Government_____
   How should the study be financed?_____
   Would you be willing to assist such a study group? Yes_____ No_____
   (If yes, check one) Financially_____ As an Advisor_____

10. Additional remarks at any length are welcomed --_____

_____

_____

_____

_____

_____
Signature (Optional)

Please return completed questionnaire to:
The Executive Secretary, American Geophysical Union,
1515 Massachusetts Ave., N. W., Washington 5, D. C.